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Silvicultural Control of Dwarf Mistletoe in Southwestern Ponderosa Pine

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This long-term study was initiated in 1951. Three treatments—light improvement selection, limited control, and complete control—were tested. After 27 years, it appears that complete removal of infected overstory and understory trees is the only effective silvicultural method of controlling dwarf mistletoe in mature stands of southwestern ponderosa pine.

Keywords: *Arceuthobium vaginatum, Pinus ponderosa,* silviculture

In 1951, a study was begun on the Fort Valley Experimental Forest, near Flagstaff, Ariz., to determine the feasibility of controlling dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum* (Engelm.) Hawksw. and Wiens) in heavily infected mature stands of ponderosa pine (*Pinus ponderosa* var. *scopulorum* Engelm.) silviculturally. The study, which was originally scheduled to run for 30 years or longer, was intended to answer the following questions:

1. Can dwarf mistletoe in heavily infected mature stands be controlled through such silvicultural measures as harvest cutting and stand improvement?
2. What is the influence of light improvement selection cutting on dwarf mistletoe?
3. What are the relative costs and returns from practices that stress dwarf mistletoe control?
4. Is dwarf mistletoe control a sound management objective in heavily infected stands?

Descriptions of study treatments and interim findings were given by Herman (1961) and Heidmann (1968). A brief description of the study follows.

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Treatments and Methods

The study was established in a virgin stand of ponderosa pine in which 45% of all trees were infected with dwarf mistletoe. It consisted of three treatments replicated three times on nine 25-acre plots. Each plot was surrounded by a buffer strip that received the same treatment as the plot. The total treated area of each plot and buffer strip was 40 acres. The three treatments were:

1. Light improvement selection (LIS). This was the cutting method used by the USDA Forest Service in virgin stands of ponderosa pine in the Southwest at the time of study establishment. It was used in this study as a standard for comparative purposes.
2. Limited dwarf mistletoe control (LC).
3. Complete dwarf mistletoe control (CC).

Under the LIS system, mortality losses in a virgin stand are reduced by harvesting all merchantable trees that are dying or are expected to die during the following cutting cycle (20 years).

Treatment of LC plots involved a rather complex procedure (Heidmann 1968). The original plan was to remove most of the infected overstory and to thin and prune in the understory, depending on degree of infec-

tion and stocking. All trees in some groups were so severely infected, however, that they would have jeopardized existing or subsequent reproduction if they had been retained. In such infection centers, the entire group was cut, creating large understocked openings. Since nearly all trees remaining after the initial treatment on LC plots were needed for stocking, infected trees were not cut or poisoned during the 1958 retreatment. All infected trees, however, were pruned and left for stocking, regardless of residual infection (Heidmann 1968).

Under the CC treatment, all infected sawtimber trees were cut or poisoned. Infected poles, saplings, and seedlings needed to maintain the desired stocking level were pruned, providing all visible infections could be eliminated. No trees below sawtimber size with bole infections, branch infections within 12 inches of the bole, or unreachable infections were retained.

Chronology

In 1951, all infected overstory trees were removed from CC plots and most of the infected overstory trees from LC plots. Under LIS, 35% of the sawtimber volume was harvested, while the figure for LC and CC plots was 78% and 75%, respectively. In 1953, cultural measures were initially applied on CC and LC plots to eliminate or drastically reduce dwarf mistletoe infection. In 1958 and 1959, the first retreatment of the area was carried out. After initial treatment (1951 and 1953) and subsequent retreatments, complete inventories were made to determine infected and noninfected stocking by size class. Inventories were conducted using a point stocking survey (Lexen 1939) to determine the percentage of the area stocked with dwarf mistletoe-infected trees. Degree of infection for individual trees was not determined. In conducting the point stocking survey, 100 points were systematically chosen in each 25-acre plot. At each point, stocking was determined using the point as the center of a variable-sized plot. Stocking was figured by assuming that the ground space occupied by a tree is circular and expresses the space requirements for trees of different diameters in terms of the radius of a circle. A 10-inch tree, for example, will require a radius of 13-1/2 feet and a 30-inch tree a radius of 31 feet (Lexen 1939). When two trees occupy the same point, it is assumed that the larger tree usually is able to appropriate growing space at the expense of the smaller tree.

In 1963, the area was again scheduled for retreatment. However, it was believed that the additional information to be gained was not worth the cost in funds and manpower. Therefore, a point stocking survey was conducted and the study terminated (Heidmann 1968). In the late 1970's, the study area was part of a larger area scheduled for harvest. But before the plots were completely destroyed by logging, it was decided another point stocking survey should be conducted to determine the buildup in infection since the survey 14 years earlier.

Results of 1977 Survey

Stocking under all treatments increased between 1963 and 1977 (table 1). For both LIS and LC treatments, the increase was 7%. Under CC treatment, stocking increased from 53% in 1963 to 78% in 1977. Infected stocking increased slightly on LIS plots (3%), while on LC and CC plots it increased 6% (table 1). Infection in sawtimber stands increased slightly more than in pole stands (table 2). Under CC and LC treatments, the infected sawtimber stocking increased 4% and 3%, respectively, while on LIS plots it increased 7%. Infection in pole stands under LIS dropped 3%, while the increase for CC and LC was 1% and 3%, respectively.

Table 1.—Change in the percentage of mistletoe study area stocked with infected and noninfected trees from 1950 to 1977

Treatment	Nonstocked	Stocked[1]		
		Infected	Noninfected	Total
Light improvement selection				
1950	12	40	48	88
1953	20	40	40	80
1958	22	37	41	78
1963	18	44	38	82
1977	11	47	42	89
Limited control				
1950	7	46	47	93
1953	44	5	51	56
1958	45	16	39	55
1963	31	17	52	69
1977	24	23	53	76
Complete control				
1950	8	52	40	92
1953	46	3	51	54
1958	55	0	45	45
1963	47	4	49	53
1977	22	10	68	78

[1] *Stocking figures include sawtimber, poles, saplings, and seedlings.*

Table 2.—Change in the percentage of total and infected stocking in sawtimber and pole classes in mistletoe study from 1963 to 1977

Size class Stocking	Mistletoe treatment					
	LIS		LC		CC	
	1963	1977	1963	1977	1963	1977
Sawtimber						
Total	63	75	40	45	32	47
Infected	35	42	11	14	3	7
Poles						
Total	16	11	21	25	14	23
Infected	8	5	5	8	1	2

Figure 1.—Limited Control: (a) 1951—before logging; (b) 1953—after logging and first cultural treatments; (c) 1959—stumps in left and right foreground resulted from blowdown in 1957; (d) 1979—area is now well stocked with seedlings and saplings.

Discussion and Conclusions

These findings apply only to mature stands of ponderosa pine heavily infected with dwarf mistletoe. The management objective in these stands should be to harvest and regenerate them most effectively.

The first step is to remove the source of infection. All infected overstory trees, as well as those in the understory, should be cut (fig. 1). A similar conclusion was reached by Hawksworth (1961) and Heidmann (1968). The exact cutting prescription will depend upon the method of regeneration employed. On soils derived from basalt, typical of much of the Southwest, natural regeneration is very difficult to obtain. These soils are most effectively regenerated by planting; therefore, no residual overstory trees need to be left (Schubert et al. 1970, Heidmann et al. 1977). On sedimentary soils, however, natural regeneration efforts have been quite successful (Heidmann et al. 1982). On these areas, approximately 20 to 40 square feet of basal area in uninfected seed trees should be left. This amount of cover should yield enough seed for regeneration (Heidmann unpublished data) and provide sufficient shade for the new seedling crop. If the residual seed trees are infected, however, then about twice as much basal area should be left because seed production in heavily infected stands drops sharply (Korstian and Long 1922). Infected overstory trees should be cut soon after seedling establishment.

With heavily infected overstories, there is probably little point in attempting limited or partial control because the source of infection must be removed if successful control of the parasite is to be achieved (Hawksworth 1961). On LC plots, in this study, 78% of the sawtimber was removed in 1951, compared with 75% on CC plots. This amounted to virtual clearcutting of the area. Even with a heavy initial cut, 23% of the area on LC plots was infected by 1977, contrasted with 10% on CC plots. This difference is due primarily to the fact that the original prescription for the LC plots was not followed; therefore, during the 1957 and 1958 retreatment, many infected trees were left on these plots.

It may be that, after removal of the infected overstory and cultural operations in the understory, a stand with adequate stocking remains. In such situations, the area should be retreated periodically. As pointed out by Hawksworth (1961), one or two retreatments may put the stand in a position where the parasite may be kept under control during normal logging procedures when the stands are reentered. After a period of time, these stands will also need to be regenerated as already discussed.

In conclusion, to control dwarf mistletoe in heavily infected mature stands of ponderosa pine, the following measures are necessary:

1. Eliminate the source of infection in the overstory by cutting all infected overstory trees.
2. Remove infection in pole and sapling stands by cutting or pruning.
3. Retreat the area periodically.
4. Regenerate the area if needed.

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